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POTATO LEAF ROLL AS AFFECTING THE CARBOHYDRATE, WATER, AND NITROGEN CONTENT OF THE HOST

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WITH THREE FIGURES IN THE TEXT

It has been well established by qualitative tests that potato leaf roll is accompanied by an accumulation of starch in the leaves of the host. The earlier literature on this line of work has been reviewed by Murphy (5). Without restating his report it may be sufficient to note that all the references cited by him having a bearing upon the work reported herein have been examined. Approximately all efforts thus far have been not only qualitative in outlook but have pointed solely toward the location of starch.

Esmarch (2), Neger (6), Hiltner (4), and Murphy (5), by the use of the iodine test, have shown that leaf-roll disease is characterized by an accumulation of starch in the leaves. Neger has also shown that diseased leaves are low in water content. Boas (1) found by quantitative methods that the stems of diseased plants were high in amino acids. He found also that in leaf-roll plants there was a higher catalase content—and a higher hydrogen-ion concentration.

The purpose of this short paper is to set forth the results of a brief quantitative study of the carbohydrate, water, and nitrogen contents of leaf-roll potato plants as compared with healthy potato plants.

TABLE 1.—*Dry Weight and C/N Ratio*

Variety	Condition	Percentage dry wt.	Percentage total carbohydrate*	Percentage total nitrogen*	C/N ratio
Rural New Yorker (Age, 5½ weeks)	Healthy	6.79	10.80	5.99	1.80
	Leaf roll	9.49	25.01	4.67	5.35
Irish Cobbler (Age, 11 weeks)	Healthy	8.94	17.56	3.15	5.57
	Leaf roll	10.35	26.75	4.28	6.25
Early Ohio (Age, 11 weeks)	Healthy	7.17	4.47	5.57	.80
	Leaf roll	9.73	16.40	5.50	2.98

* Figured on basis of dry weight.

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MATERIALS AND METHODS

Three varieties of potatoes were used in this experiment: Rural New Yorker, Irish Cobbler, and Early Ohio. Healthy and leaf-roll plants were grown under identical greenhouse conditions. Before the time of tuber formation, the plants were clipped at the surface of the soil (healthy and diseased at the same time), weighed, and immediately crushed in 95 per cent alcohol, to which calcium carbonate had been added in amount of one gram per liter. The pulp was placed inside an electric oven and brought to a constant dry weight. It was then ground to a fine powder and used for quantitative determinations as follows: twelve grams for the reducing sugars, two grams for the polysaccharides, and two grams for the total nitrogen. For the determination of the reducing sugars and the non-reducing sugars the official Fehling solution method was used. For the polysaccharides the official hydrochloric acid method of hydrolysis was used, after which the determinations were made by the same method as for the sugars. The total nitrogen was determined by the usual Kjeldahl-Gunning method. All percentages were figured on the basis of dry weight.

TABLE 2.—*Carbohydrates in Percentage of Dry Weight*

Variety	Condition	Reducing sugar	Non-reducing sugar	Polysaccharides
Rural New Yorker (Age, 5½ weeks)	Healthy	0.60	0.40	9.81
	Leaf roll	1.30	1.66	22.05
Irish Cobbler (Age, 11 weeks)	Healthy	0.68	0.31	16.57
	Leaf roll	1.38	1.70	23.67
Early Ohio (Age, 11 weeks)	Healthy	0.10	0.27	4.10
	Leaf roll	1.15	1.80	13.45

RESULTS

Invariably the leaf-roll plants were higher in percentage of dry weight. This fact is shown graphically in figure 1, and numerically in the dry weight column of table 1. The ratio of carbohydrate to nitrogen runs consistently higher in the diseased plants, as is shown in the right-hand column of table 1 and by fig. 3. All forms of carbohydrate, reducing sugars, non-reducing sugars, and polysaccharides, are higher in the diseased plants. The data are given in table 2. The total carbohydrate in healthy as compared to diseased plants is shown graphically in figure 2.

SUMMARY

Let it be emphasized here:

1. That the plants involved in this study were grown under identical greenhouse conditions.

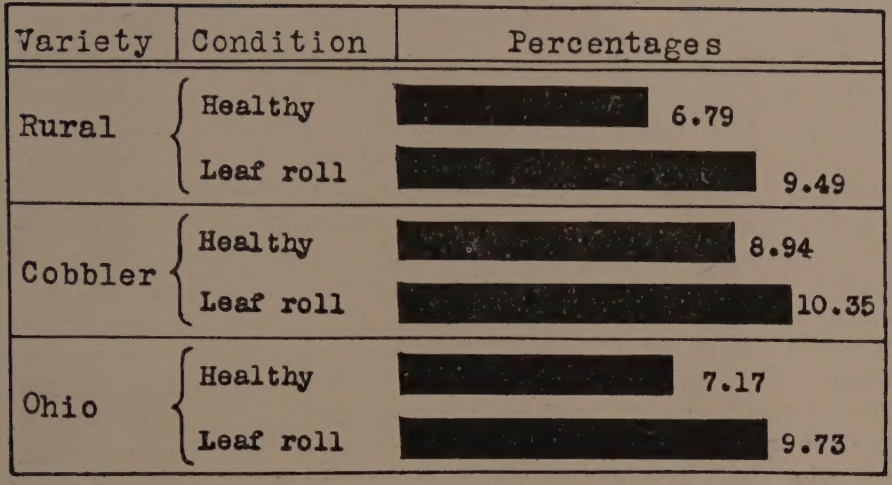

FIG. 1. Dry weight ratio.

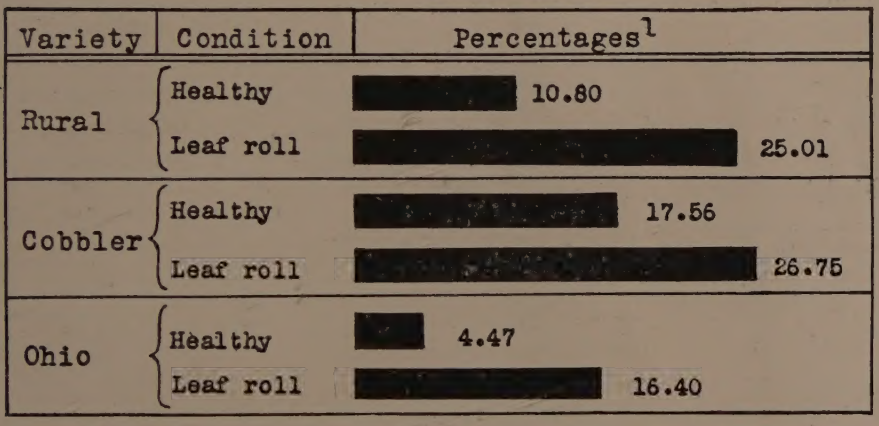

FIG. 2. Carbohydrate content. [1] Figured on basis of dry weight.

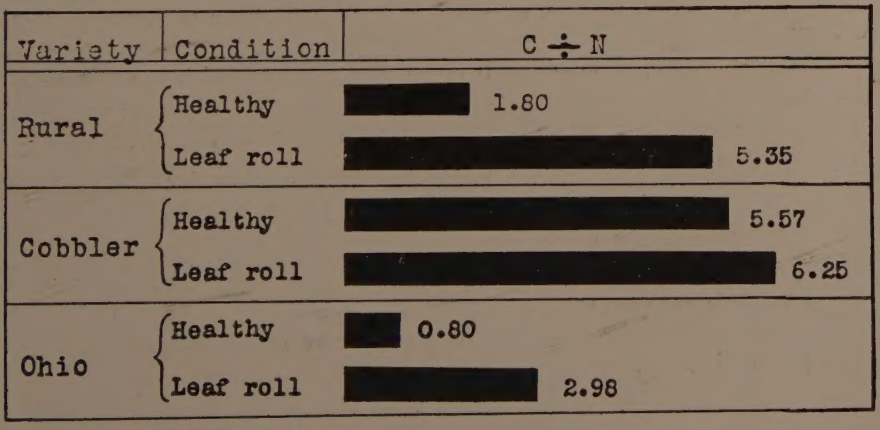

FIG. 3. Carbohydrate-nitrogen ratios.

2. That the plants were harvested prior to tuber formation.

3. That the entire above-ground portion of the plants was crushed and used in the analyses.

4. That in comparison with the healthy, the leaf-roll plants invariably showed: (a) a higher percentage of dry weight; (b) a higher percentage of carbohydrates, sugars as well as starch; (c) a higher C/N ratio; (d) and a percentage of total nitrogen approximately equivalent to that of the healthy plants on the basis of dry weight, and higher on the fresh weight basis.

REMARKS

From these facts it does not seem probable that a retarded translocation rate is the only factor causing a simultaneously high carbohydrate and low water content in the leaf-roll plants. A high sugar content under conditions of abundant external water should normally mean a correspondingly high water content for the plant, but in this instance such is not the case. It may be that the disease virus in leaf-roll plants has retarded the movement of the transpiration stream, or that possibly it has somehow stimulated photosynthetic action temporarily beyond the normal. The operation of either of these assumed possibilities or a combination of them might change the dry weight-carbohydrate ratio to an abnormal figure.

Further studies of these physiological processes are being planned in this laboratory.

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